Operational Use of Explosives Hazard Analysis and Site Planning Software

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ABSTRACT

A computer-aided explosives hazard survey system was developed by Integrated Systems Analysts, Inc. (ISA) to support the Air Force Explosive Hazard Reduction (EHR) Program. The purpose of the EHR program is to identify and qualify threats and operational restrictions posed by the presence of AF munitions stocks and recommend approaches to reduce or mitigate these threats and restrictions. The prototype of this system was put into operational use at Hill Air Force Base, Utah, in October 1994. More than 1450 facilities were surveyed for potential hazards based on the criteria in the Air Force Explosives Safety Standards.

This paper will provide the reader an overview of the surveys results and automated explosives site planning capabilities.

INTRODUCTION

Hill Air Force Base has a variety of operations that span the entire life cycle of AF munitions. Over 500 explosives related facilities, managed by Hill AFB, are located at three separate Utah installations. These operations include static firing of large missile motors; test functioning small munitions components; storage of large missiles and standard airmunitions packages (STAMP); shipping munitions to all parts of the world and numerous aging and surveillance programs. In addition, Hill AFB supports two F-16 fighter wings with associated explosive operations. Integrating these explosive operations to ensure mission accomplishment and at the same time achieve an acceptable level of safety is a continuing challenge for Hill AFB managers and weapons safety personnel. A major part of this challenge is to ensure the explosive safety quantity-distance (Q-D) criteria is properly identified and implemented. Anyone who has worked with Q-D standards immediately recognizes how complex and frustrating this can be. Explosives safety site planning is a perfect example of this complexity and frustration. It is time consuming, prone to error and the process is tedious. Maps are typically inaccurate and incomplete. Q-D standards consistently change and not to mention the endless stream of different interpretations of Q-D criteria. Several years ago the Hill AFB weapons safety office made a relatively successful attempt to develop an independent map of the Hill AFB munitions storage areas using a CAD

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program. This map provided an excellent tool for measuring, calculating and drawing. However, because of the complexity of explosives safety criteria and the need for an even better map, explosive site planning was still an effort for the most experienced weapons safety specialists assigned to Hill AFB.

During the DDESB Explosive Safety Seminar held in Anaheim, California in August 1992 a representative of the Hill AFB weapons safety office attended a demonstration by Integrated Systems Analysis, Inc. (ISA) of a computer program that would identify and quantify explosives hazards. They were under contract to the USAF Explosives Hazard Reduction (EHR) Program Office to study several Air Force bases and recommend solutions to hazards uncovered by the system. The system is referred to as " Assessment System for Hazard Surveys" (ASHS). Based on this demonstration ISA was contacted and a survey was scheduled.

DESCRIPTION OF ASHS

ASHS is a Geographic Information System (GIS) based spatial analysis approach to analyzing hazards. The GIS is linked to a database and a custom computer code developed to assist in mapping and analysis. The system has been successfully used at several bases as a hazard assessment system and is easily adapted to explosives site planning. Hill AFB is currently using a prototype system for explosives site planning.

The Hill AFB prototype uses the ISA system on a Macintosh computer. It was developed around two commercial software programs. MapGrafix™ a Geographic Information System from ComGrafix and 4th Dimension ™ a relational database from ACI. ISA is currently developing a PC based version of the system.

To observe the Hill AFB prototype now in use appears to be "magic." Current capabilities, potential capabilities, "what if" scenarios and site plans can be obtained quickly and accurately. However, getting to this point has not been easy. It took two years of map development/verification and facility database validation, plus considerable training in program and computer use. However, it has been well worth the effort.

POTENTIAL HAZARDS UNCOVERED

The primary purpose for bringing the ISA prototype to Hill AFB was to improve the explosives site planning capability. However, the first time the system was run, many unexpected potential explosives threats were discovered. Most were caused by inaccuracies in the previous maps and interpretation of standards. Some were in explosives safety criteria that had changed over the years. Others were oversights primarily because of the complexity of explosives safety criteria. A few were utilities put in place without coordinating with the Weapons Safety Office.

Following are examples of some identified potential hazards:

1. Violation of intermagazine distance between an igloo and explosives cargo aircraft. The 60^0 arc from the headwall of an igloo intersected a portion of the cargo bay of an explosives loaded cargo aircraft on a parking pad. See Figure 1

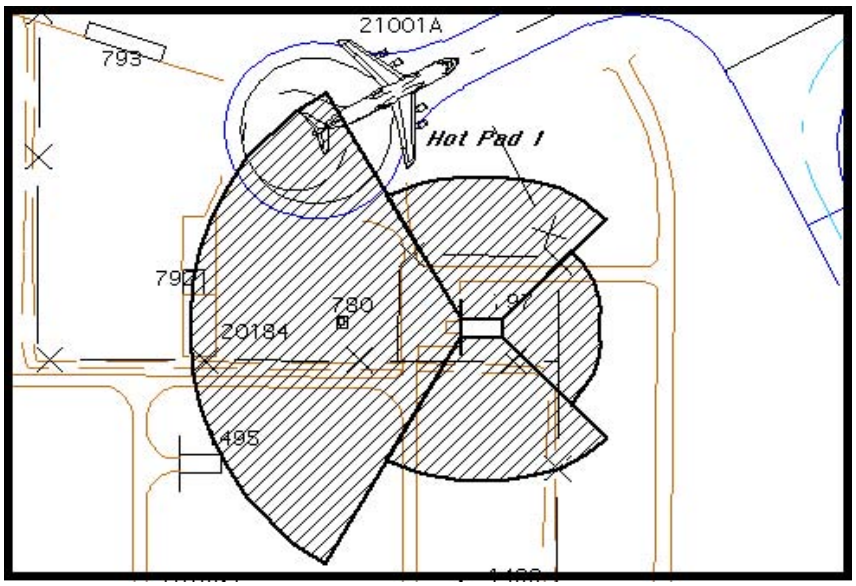

Figure 1

2. Missile transport trailers parked at designated power outlets in front of igloos violated aboveground unbarricaded intermagazine distance from the headwall of igloos in the row behind the designated igloos. See Figure 2.

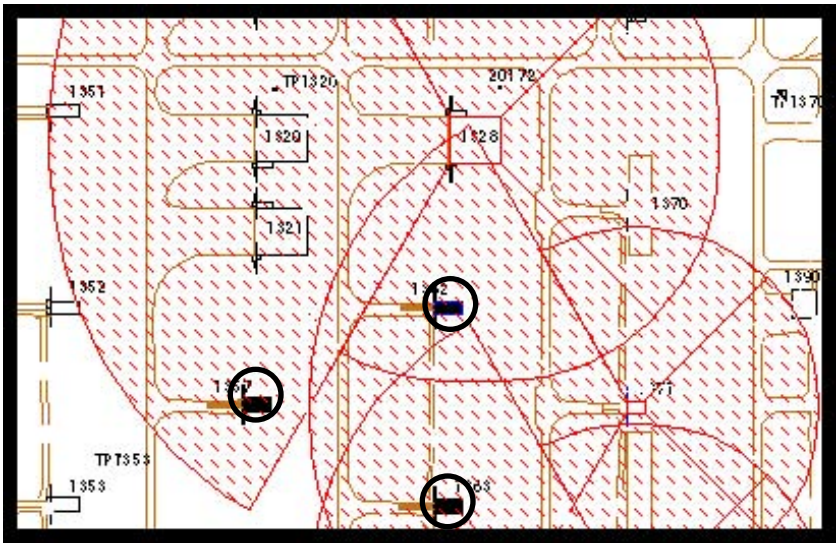

Figure 2

3. The inhabited building clear zone of an explosives X-ray facility, under construction, overlaps the playground of a proposed housing area. See Figure 3.

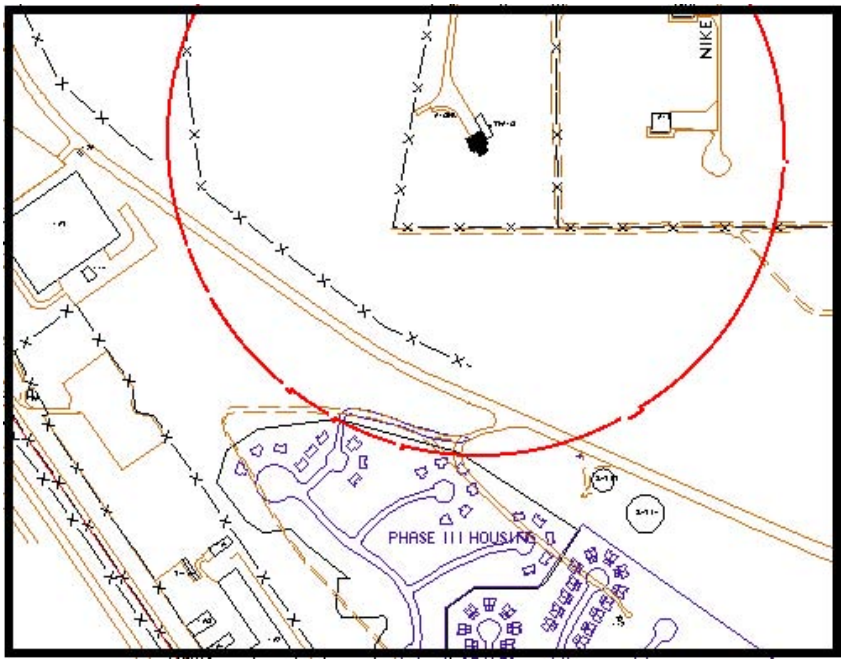

Figure 3

4. A petroleum refuel station violates minimum inhabited building distance to 15 facilities and reduces the capability of 25 more storage facilities. The associated fuel tank was a converted water tank that was partially underground and covered with earth. This meets the underground utility requirement, however, the pipe used for refueling is not protected and requires inhabited building separation.

5. A water well pumping station violates the required public transportation route separation to an explosive cargo aircraft pad. The station supplies water to an underground storage tank that supports not only the munitions storage area but other areas outside of the explosives clear zone. See figure 4.

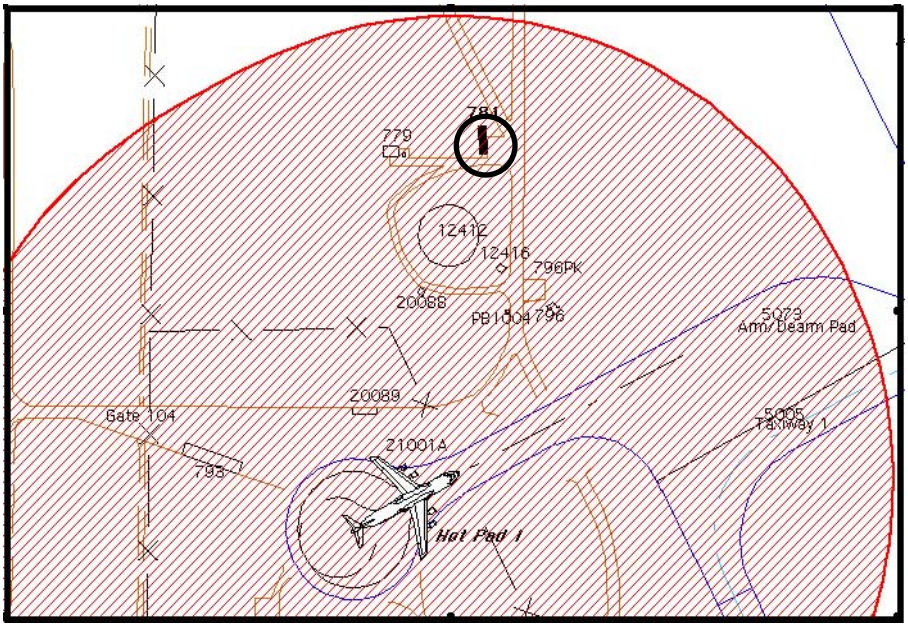

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Figure 4

RESOLUTION OF THREATS

Fortunately, with the help of the ASHS system, most of the threats were relatively easy to correct. Many of the problems were resolved by slightly reducing the storage capabilities of the facilities. While some explosives limits went down, others went up. Some problems involved the storage of Hazard Class/Division 1.2 munitions. The ASHS system can identify and help resolve problems with all divisions of explosives. Following are the resolutions for the above examples.

1. The parking spot for the aircraft that intersected the 60^0 arc of the igloo was moved forward a few yards so the cargo compartment would be out of the hazard area, as shown in figure 1. The ASHS system can precisely identify the explosive cargo compartment which allows the correct positioning of the aircraft nose wheel.

2. Explosives limits in the igloos affected by six of the missile trailer parking spots were reduced temporarily until a new consolidated parking area can be constructed. Two of the missile parking spots were eliminated because the mission would not allow reduction of the explosives limits in the affected igloo. See Figure 5. With help from the ASHS system, a new location for a ten trailer parking area was identified.

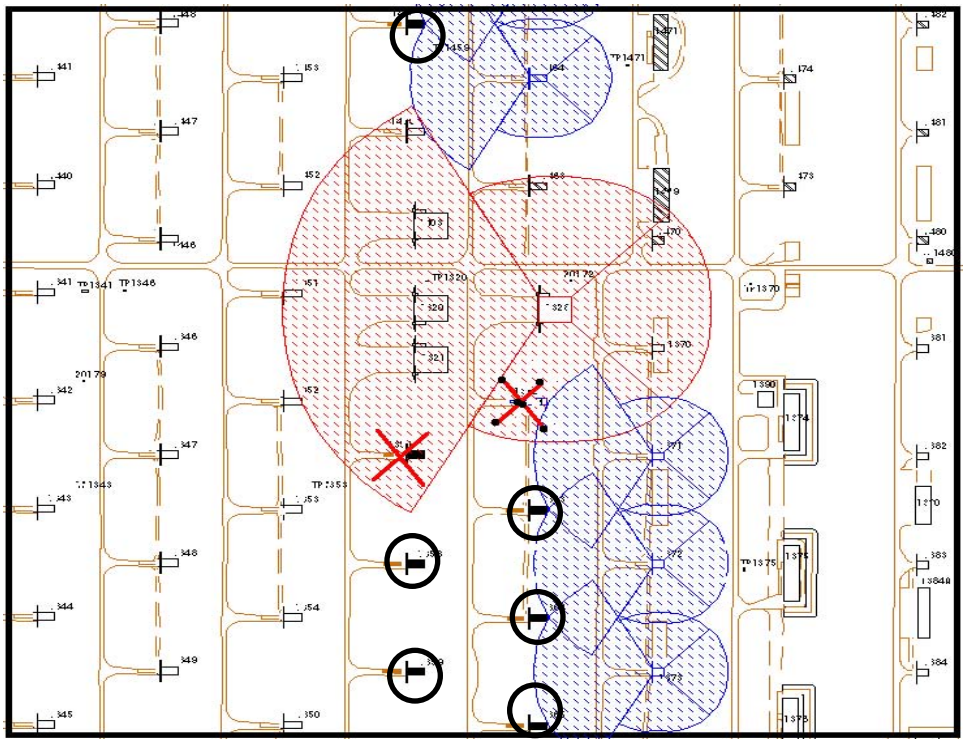

Figure 5

3. The encroachment of a housing development into the clear zone was created because of a misunderstanding by the architect. He believed only the houses needed to be out of the explosives clear zone. The playground and outer wall were within the inhabited building distance. Reducing the explosives limits in the X-ray facility by approximately 5000 pounds moved the clear

zone outside of the wall and had only a small effect on the mission of the facility. This error may have gone undetected if the old inaccurate base maps were used.

4. During the oil shortage in the 1970's, a water tank was converted to POL storage without proper quantity distance evaluation. Fortunately the tank itself was a "cut and cover" tank and met quantity distance requirements. However, the refuel stand was exposed and required inhabited building separation. This fuel tank system has been taken out of service.

5. The water well pumping station violation is the only remaining waiver at Hill AFB. The long term corrective action is to move the well. The risk of this hazard is minimal and it is hard to justify the significant cost to correct the problem. All other waivers and exemptions at Hill AFB have been eliminated with the help of the ASHS system.

EXEMPTIONS AND WAIVERS ELIMINATED

Prior to ASHS, Hill AFB had 55 permanent exemptions for vehicle parking in the munitions areas and 8 waivers. All exemptions and all but one waiver have been eliminated. Using the ASHS system made the task of eliminating these exemptions a lot easier. Different configurations were easily tested and adequate parking was squeezed into accessible locations with minimal lowering of explosives limits. The boundaries of each parking lot are identified and the space and layout meet the Air Force standard for parking lots. See figure 6 for examples of parking areas. 2114APK is a government vehicle parking lot; 2114APKA, 2113BPK and 2148PK are private vehicle parking lots. The parking lot numbering sequence tells the computer which facility the parking area supports. In this way the proper quantity distance criteria can be applied.

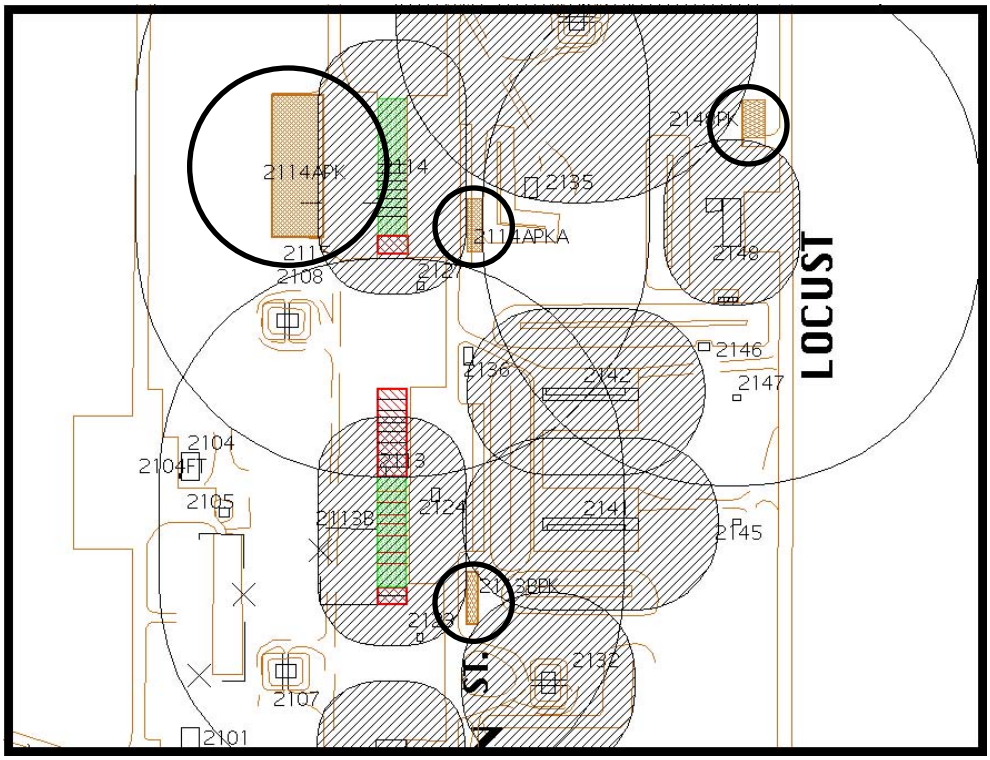

Figure 6

AUTOMATED SITE PLANNING

The Map

It has been a long time goal of the military services to automate explosive site planning. There have been many attempts to achieve this goal, some meeting with more success than others, but never reaching total automation. The ASHS system developed by ISA comes closest to meeting this goal. Although originally designed to identify quantity distance deficiencies, at Hill AFB it has taken the larger role of assisting agencies in explosive safety clear zone management.

Generally speaking explosives site planning can be an exhausting process. First there are the maps to find. Having a current and accurate map is the foundation of a meaningful explosives site plan (ESP) and without one the process is a waste of time. Finding an acceptable map can be an effort and may mean several trips to the civil engineer mapping function only to bring back rolls of paper you don't need. Just by the nature of maps, they are not always current, accurate or available for a particular area.

When the map for Hill AFB was created for use with ASHS, the ISA team members drew on a variety of information to produce an extremely accurate and complete map. This information included "As Built" drawings, actual measurements, 1"=50' aerial maps, and a walk and drive through survey of the entire clear zone. To verify the accuracy of the map, the Civil Engineering organization surveyed ten different facilities on the map. Each location was within 1' of its actual location. As a result, the map created for hazard identification is now the official base map.

The mapping system allows the site planner to do a number of useful tasks faster and more efficiently. As an example, the DoD Explosive Safety Board requires 1"=400' maps to be submitted with each ESP. In the past, large maps using only a portion of the map to show the site plan area had to be submitted. With this system a clear zone based on 50,000 pounds of Cl/Div 1.1 can be drawn on a standard 8.5" X 11" piece of paper at the 1"=400' scale. This in itself adds to the timely submission, saves on paper, is easier to mail and is easier for the reviewers to handle. Larger clear zones require some creativity such as finding a larger printer or cutting and pasting. This system also allows color coding of potential explosive sites, exposed sites and clear zones. Even more significant, the entire explosives site plan can be submitted electronically.

Also the MapGrafix^{TM} map can create a number of layers for specific purposes. As an example all storage, operating and open pads at Hill AFB were placed on a separate layer and all utilities on another layer. Still other layers contain important map features essential to a complete site plan. All layers can be turned on or off to produce the desired map on a single sheet of paper. As an example, it is fair to say that utilities might often be overlooked when preparing an ESP. In the AF there are distinct maps that show different features of the installation. The Tab C map shows features above ground and Tab G Maps show the different utilities. If you have

ever tried to put all of these maps together in three or four copies for an ESP, you will realize the saving in time, money and effort when only a single page is required.

Let's look at some other system site planning features. This system has the capability to create templates. One type of template found to be very useful at Hill AFB is that of aircraft. These aircraft are to scale and can be imported into the basic map. Figure 7 is an example of F-16 fighter aircraft on a ramp. Once the template is placed in the map, all of the analytical tools can be applied. The exact location of the payload compartment of a cargo aircraft or location of ordnance on a fighter can be precisely identified as the PES. This allows for very accurate application Q-D resulting in a more efficient use of limited land area. A template can be created for any PES or ES. Figure 8 shows some examples of aircraft templates available.

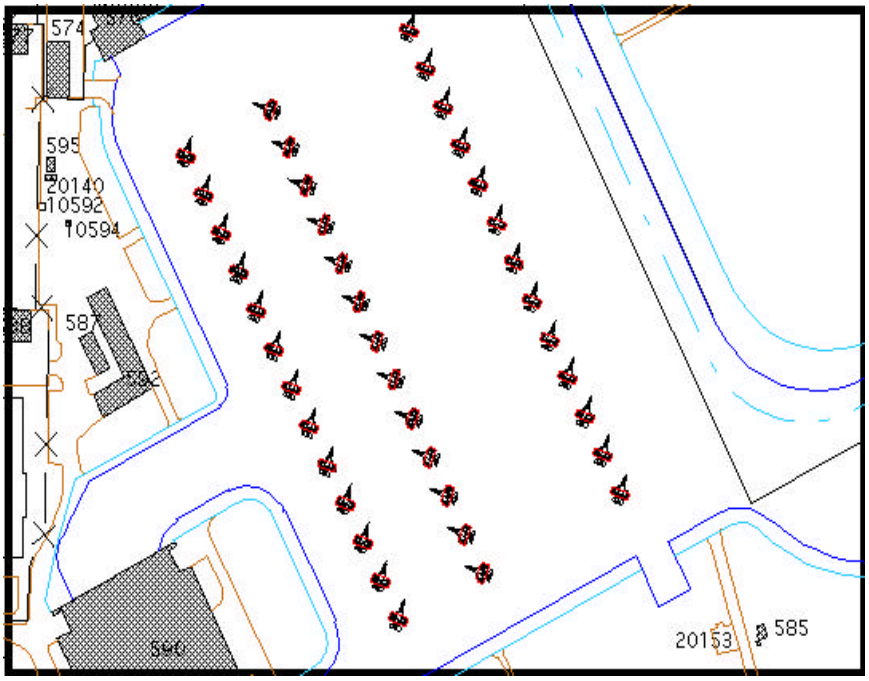

Figure 7

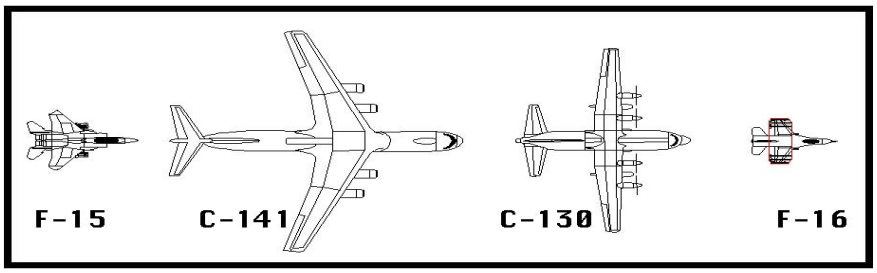

Figure 8

If you have drawn by hand a number of circles or other shapes on a map you know it can be a tedious undertaking. At Hill AFB we often site multiple PESs with multiple ESs. It was a very time consuming operation to draw circles on multiple sets of maps. This system can repli-

cate all the shapes and sizes of any form in a matter of minutes. Figure 9 shows an example of IM clear zones around igloos.

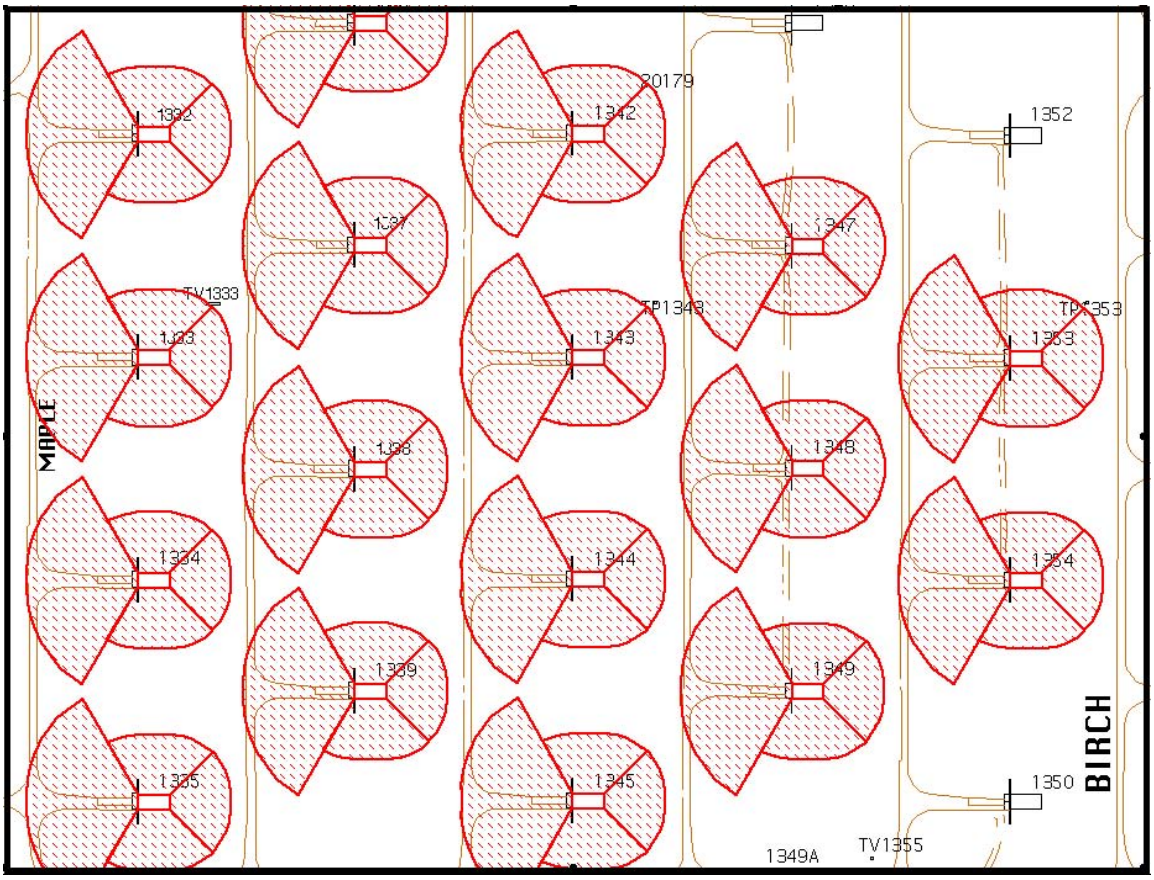

Figure 9

These are only a few of the capabilities of this system. There are many more that will help you in siting explosive or non explosive facilities.

The Database

If the creating of an accurate map in the ASHS system is the foundation of a credible ESP, then the database is the heart and soul of the ESP. The database can accommodate most data required in an ESP. There are several important records contained in this database. One is the "Facility Record" which contains specific information on the facility such as facility size, type of construction, ownership and other such information as shown in Figure 10. Another important record in the database is "PES-ES Worksheet" as shown in Figure 11. The record contains a variety of information relating to application of Q-D between a PES and any number of ESs. The database then contains the necessary data on the facilities and explosive Q-D criteria needed to create an explosives site plan. During the latest survey using the ASHS system at Hill AFB,

some 46,700 relationships between the facilities were analyzed for distance and compliance with explosive Q-D criteria. This was accomplished in a matter of hours. The same effort without ASHS would have taken months.

In addition the database can be used to manage data, perform calculations and even produce sophisticated reports.

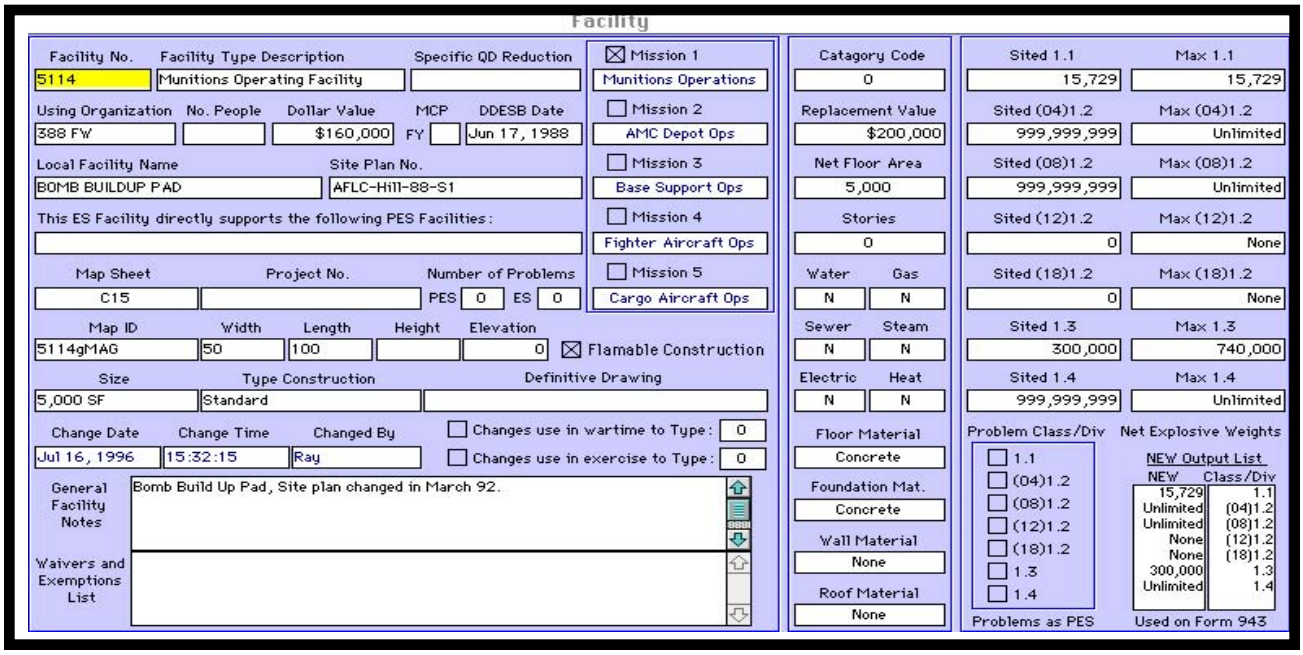

Figure 10

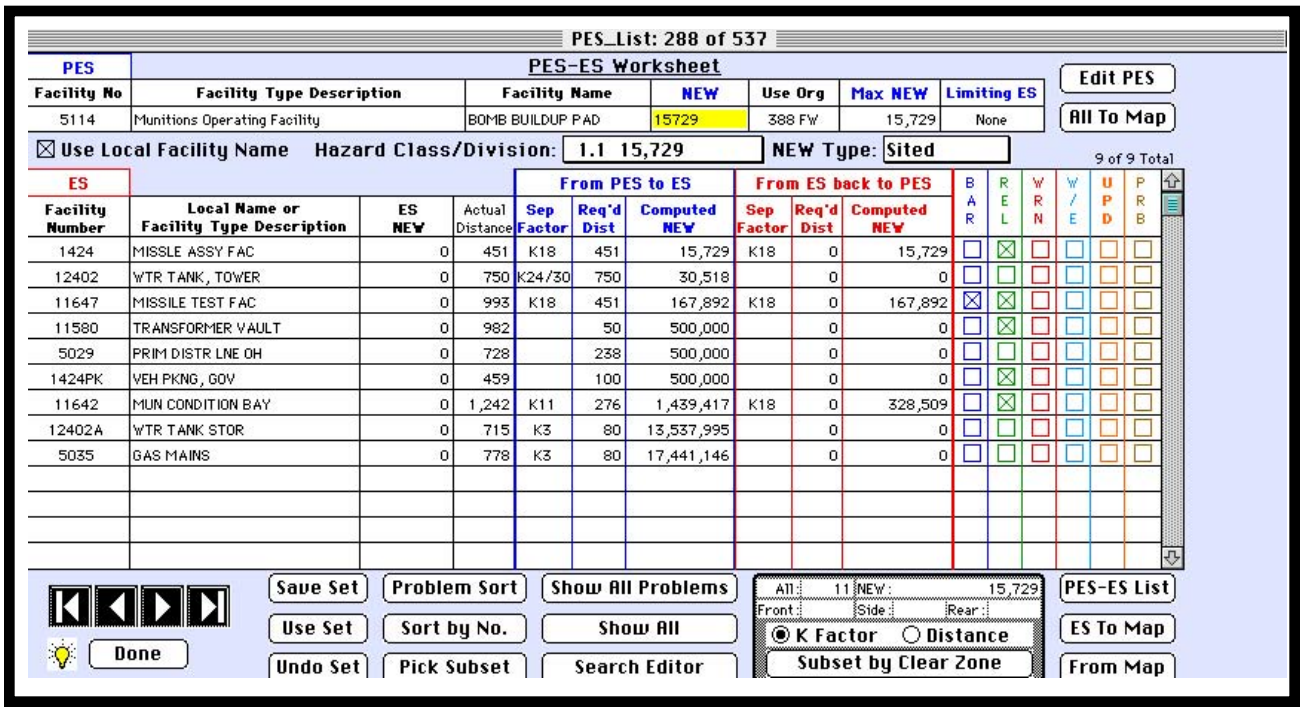

Figure 11

The many different kinds of information contained in the 4th Dimension Database, with respect to the facilities within the clear zone, provide a powerful tool to help managers make better decisions about the effective use of the limited area within the explosive safety clear zone.

As an example, upon completion of the initial Q-D evaluation at Hill AFB and the resolutions of the threats, it became apparent by using the database and the quick report capability that many of the facilities were sited for explosives authorizations in excess of what the mission of the facility needed or what it could physically contain. The land taken up by the Q-D because of the excessive amounts of explosive authorizations could be better utilized. As an example, many of our igloos have been modified for Minuteman Missile storage. These igloos, vintage 1941, can only store one complete motor set with a maximum NEW of 7400 pounds of Cl/Div 1.1. The average authorization is 176,116 pounds. The difference of 168,716 pounds drives unnecessarily large distances to other exposed sites which results in less area for other possible facilities. Given the fact that these igloos can be reduced to 7400 pounds of CL/Div 1.1 there is enough room to place 20 plus pads for parking explosive loaded vehicles. See Figure 9.

CONCLUSIONS

The ASHS system has certainly enhanced the explosive site planning capability at Hill AFB. Site plans are more accurate and easier to prepare, but more important, the system is an excellent management tool. Questions from the functional managers and unit weapons safety representatives can be answered quickly and accurately. The system has its most potential with large complex explosives programs. Though it is a lengthy and arduous process to set up the system, a tremendous amount of valuable information is learned about the explosives related facilities during the set up process.

Smaller explosives areas can benefit if the initial set up is accomplished by a knowledgeable explosives safety specialist. A less knowledgeable individual can then accomplish explosives site plans if they have adequate computer training.

Computer training is a key element in the success of the system. Because explosives safety criteria is complex, the computer program is inherently complex. Even though ISA is continually attempting to make the system more user friendly, unless explosives safety criteria is made simpler, using the system will always be a challenge to the novice.